Collaborative Research on Resilient Infrastructure and Sustainability Education: Addressing the Challenges faced by STEM Students following Hurricane Maria in Puerto Rico

Panelists: Carla López del Puerto, O. Marcelo Suárez, Humberto Cavallín and Canny Bellido

Hurricane Maria made landfall on September 20, 2017, near Yabucoa, Puerto Rico causing major damage to the island's infrastructure. In the aftermath of the storm, Puerto Ricans had limited access to clean water, electrical power, communications, and basic healthcare services. The devastation led to over 3,000 deaths and increased awareness regarding the disproportionally large impact of natural disasters on vulnerable populations, such as university students.

This panel will present four NSF-funded projects sharing the common goal of providing support to STEM students to ensure that they succeed despite the challenges imposed by the aftermath of a natural disaster.

- The **CREST** Phase II Nanotechnology Center for Biomedical, Environmental and Sustainability Applications[1] showed its true commitment to outreach by helping out the communities served through the Center's strategic network of Materials Science & Engineering clubs hosted by public intermediate and high schools. In the wake of the storm, CREST staff, professors, and students sometimes with the assistance of the US National Guard tended to those communities to provide assistance to families in dire needs. Students supported by the Center continued to excel in their research despite the challenging conditions. This is evinced by the research awards and recognitions that students received in profesional conferences just weeks and months after the hurricane.
- The Ecosystem to Expand Capabilities and Opportunities for STEM Undergraduates[2] (**EECOS**) was designed following Hurricane Maria to provide students with (1) financial support, (2) academic support, and (3) socio-emotional support to increase retention and graduation. In addition, the project team will generate important knowledge about student resilience and persistence after a natural disaster, the importance of an ecosystem of support that includes academic and socio-emotional support systems, and the validity of the adage that financial aid alone cannot increase student success.
- The Program for Engineering Access, Retention, and LIATS Success[3] (**PEARLS**) addresses college access and economic hardships of Low-Income Academically Talented Students (LIATS). The project provides financial and academic support and investigates the effectiveness of an institutional intervention model seeking to increase the retention and academic success of talented engineering students coming from economically disadvantaged families.
- The Resilient Infrastructure and Sustainability Education – Undergraduate Program[4] (**RISE-UP**) was designed in the aftermath of Hurricane Maria in response to the need to train future professionals to design and build infrastructure that can withstand the impact of natural events. After the natural disaster, it became evident that multiple disciplines need to come together to rebuild the damaged infrastructure using new paradigms. The project is a collaboration among three University of Puerto Rico campuses. It includes a novel interdisciplinary curricular sequence that emphasizes the development of research skills (experiential learning) and case study research and turns them into hands-on solutions for real problems/projects.

[1] NSF #1345156; [2] NSF S-STEM # 1833989; [3] NSF S-STEM #1833869; [4]NSF HSI # 1832468, 1832427

This session will provide a brief overview of the four NSF-funded projects highlighted above. A discussion with questions from the audience will follow addressing blooming collaborative efforts and synergy among the projects to broaden the social impact of these NSF-funded endeavors. Finally, the session will wrap-up with a summary that would serve the Foundation to become more effective in funding high impact STEM research where underrepresented minorities are involved.

Panelists

Prof. Carla López del Puerto is an associate professor in the Department of Civil Engineering and Surveying at the University of Puerto Rico, Mayagüez (UPRM). She received her B.S. in Architecture from Universidad de las Americas-Puebla, her M.S. in Construction Management from the University of Oklahoma and her Ph.D. in Higher Education Administration from Saint Louis University. Prior to joining UPRM, she was a designer and cost estimator for The Benham Companies, an instructor at Southern Illinois University and an assistant professor at Colorado State University. Her research focuses on design and construction management, education and training. She is currently principal investigator of RISE-UP and senior personnel of ePEARLS.

Prof. Oscar Marcelo Suárez obtained his PhD in Metallurgical Engineering from the University of Wisconsin – Madison and is the coordinator of the graduate program in Materials Science and Engineering at the University of Puerto Rico - Mayagüez (UPRM), the only one in its type in Puerto Rico. He is also the director of the NSF-funded Nanotechnology Center Phase II, a ten-year old effort and the largest investment of the Foundation at UPRM. His areas of research and interests range from aerospace materials and metal additive manufacturing to sustainable building materials as well as public education. He is currently co-principal investigator of RISE-UP and ePEARLS, two NSF initiatives that are the core themes of this panel.

Prof. Humberto Cavallín: Faculty at the School of Architecture, Rio Piedras Campus /UPR. Holds a professional degree in Architecture, a PhD on Design Theory and Methods in Architecture from University of California, Berkeley, and a Master of Science (MSc) in Social Psychology at the Universidad Central de Venezuela. Current research focuses on problem solving in design, and the role of architectural design on the microbiology of the built environment."

Prof. Canny Bellido is a School & Educational Psychologist and a full professor in the University of Puerto Rico at Mayagüez Teacher Preparation Program and the Psychology Department. The Founder and Coordinator of the UPRM Resource Center for Education Research and Services Center (CRUISE), Dr. Bellido has directed or evaluated more than 17 education research, professional development, and outreach projects. She has coordinated the campus Center for Professional Enrichment for ten years. She is a co-principal investigator of the NSF EECOS S-STEM project and the Science State Coordinator for Presidential Awards for Excellence in Mathematics and Science Teaching.

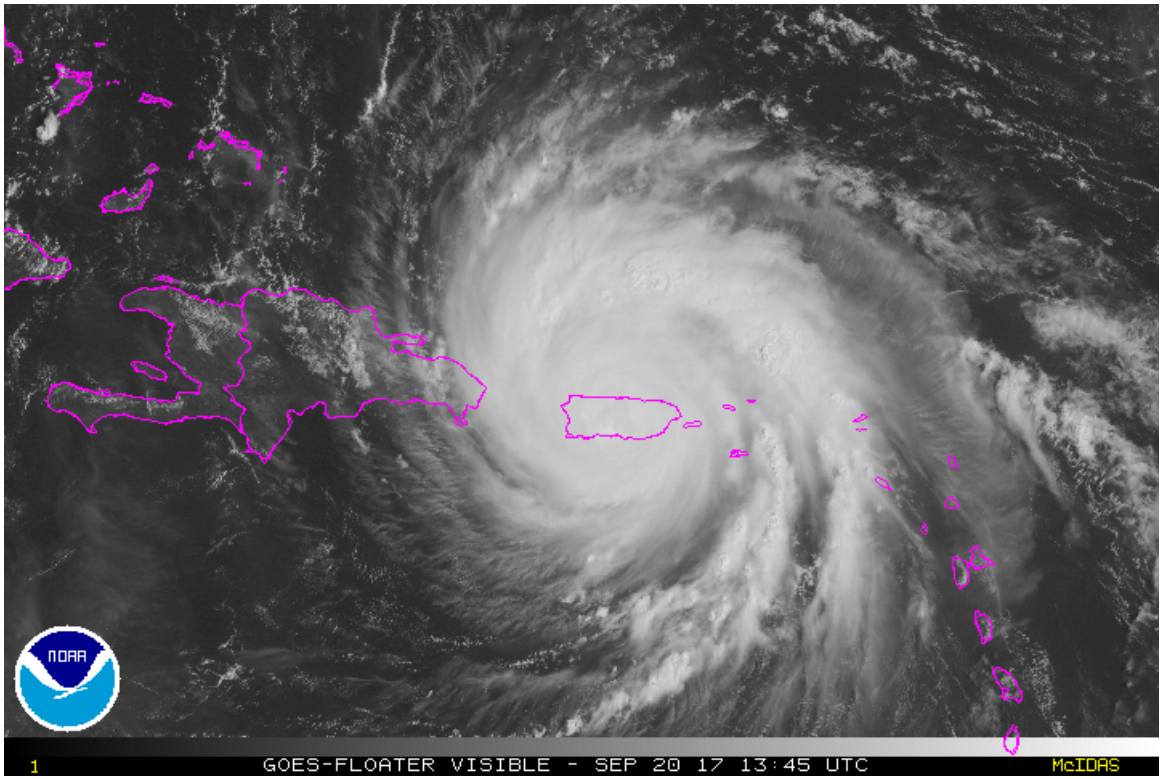
Collaborative **R**esearch on **R**esilient **I**nfrastructure and **S**ustainability **E**ducation: Addressing the Challenges faced by STEM Students following Hurricane Maria in Puerto Rico

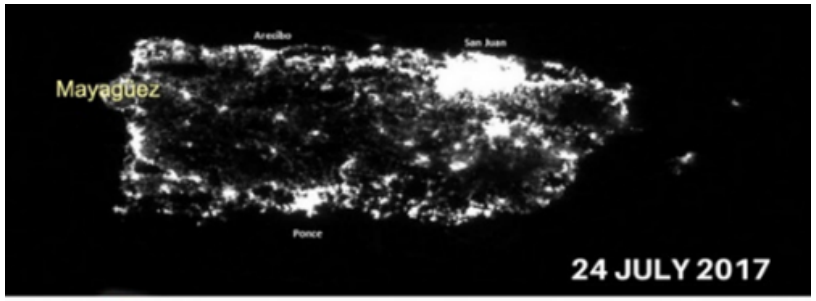
Panelists:
Carla López del Puerto, UPR – Mayagüez
Marcelo Suárez, UPR – Mayagüez
Humberto Cavallín, UPR – Rio Piedras
Canny Bellido, UPR – Mayagüez

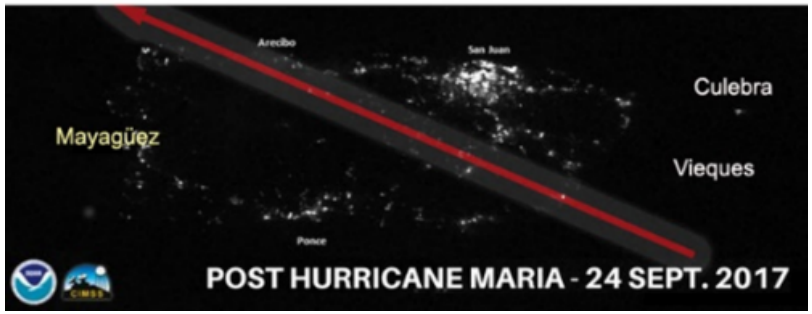
HSI# 1832468; 1832427
1345156; 1833869; 1833989

Agenda

I. Hurricane María
II. Brief project overview
   - CREST
   - EECOS
   - ePEARLS
   - RISE-UP
III. Discussion
IV. Summary







Nanotechnology Center: 10 Years in the Trenches

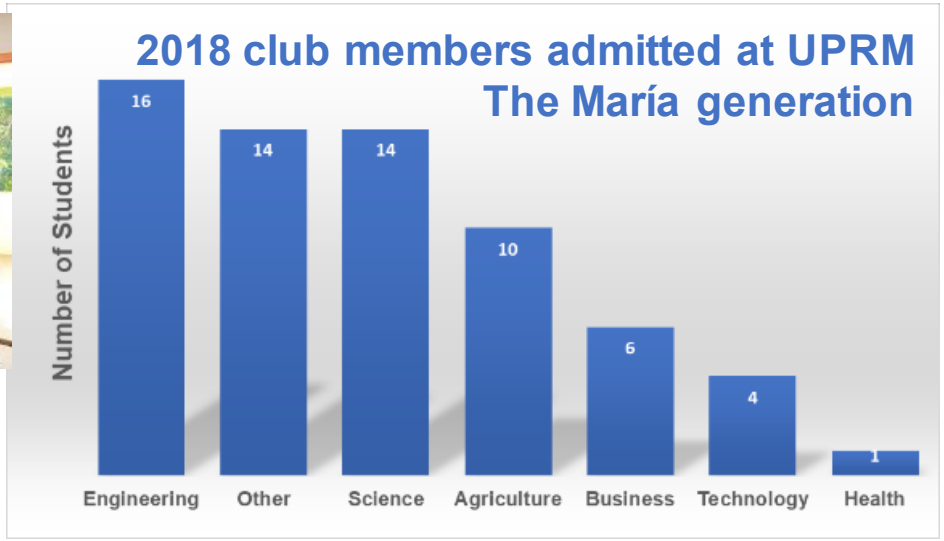
Oscar Marcelo Suárez

crest UPRM II
crest2.uprm.edu

NSF Awards Nº 083112 & 1345156

Our Materials Science & Engineering Clubs in public schools:
Foundries of Hope

- Five intermediate schools
- Ten high schools
- 291 female
- 228 male



The bottom line: Fourteen of those schools serve households from 50% to 98% below the poverty line

The Annual Club Meeting at the UPRM Coliseum

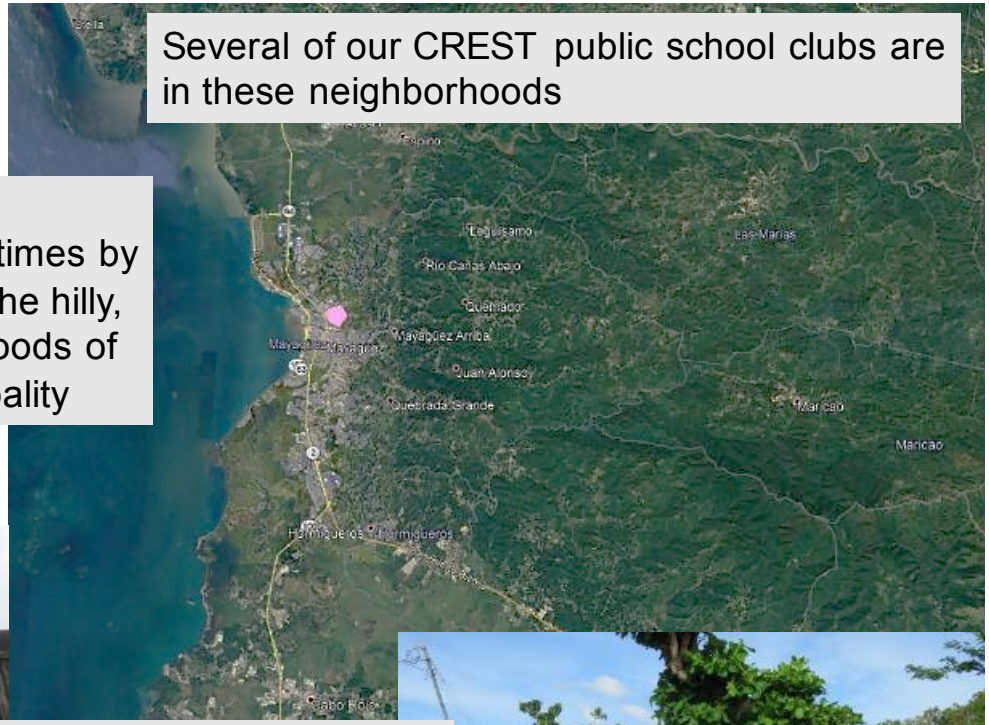
13 months after María

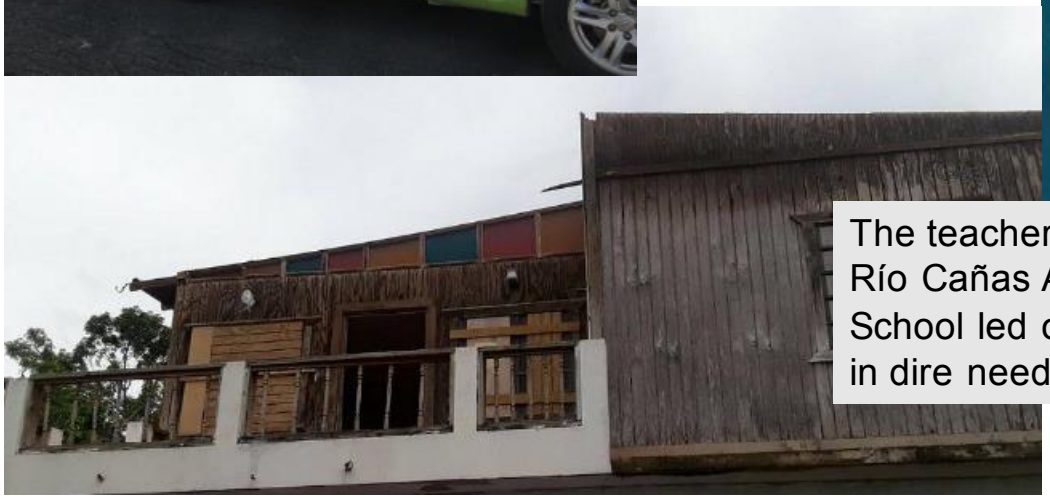
always hosted by Nanito

Nothing can be done without our bravest teachers, real life superheroes

A true commitment to outreach: Helping out the community after the storm

Sometimes joining the National Guard, sometimes by ourselves, we visited the hilly, devastated neighborhoods of the Mayagüez Municipality





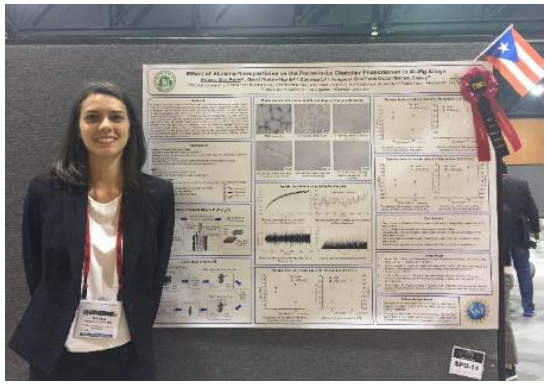
The teacher mentor of the club at Río Cañas Abajo Middle Public School led our team visiting families in dire needs

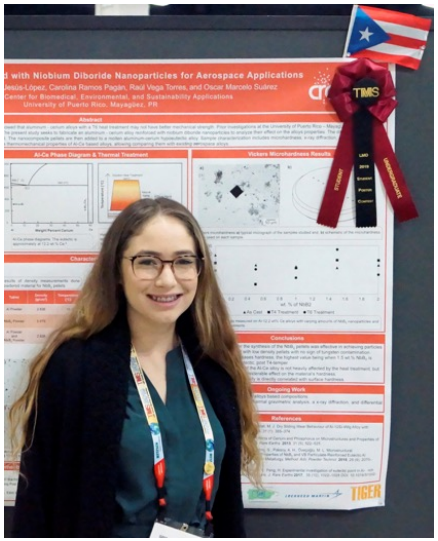
When the night is darker / Thou shalt shine brighter

Andrés Calle, graduate, Industrial Engineering. Defense Innovation Challenge, Tampa, FL, October 2017 (18 days after the hurricane). Defense Innovation Award.

Yamalis López, undergraduate, Chemical Engineering. National Diversity in STEM Conference, Salt Lake City, UT, October 2017 (one month after the hurricane). Best poster presentation, Engineering category

Mónica Díaz, undergraduate, Chemical Engineering. TMS Annual Conference, Phoenix, AZ, February 2018 (five months after the hurricane). First Prize, Structural Materials Division of TMS.

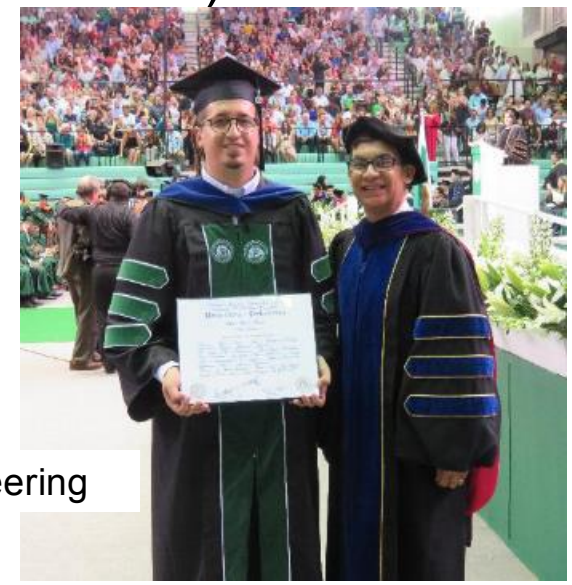




Julie Ann Colón, undergraduate, Chemical Engineering. TMS Annual Conference, San Antonio, TX, March 2019. First Prize, Light Metals Division of TMS.

Graduation in June 2018 (9 months after the hurricane)

BS in Civil Engineering



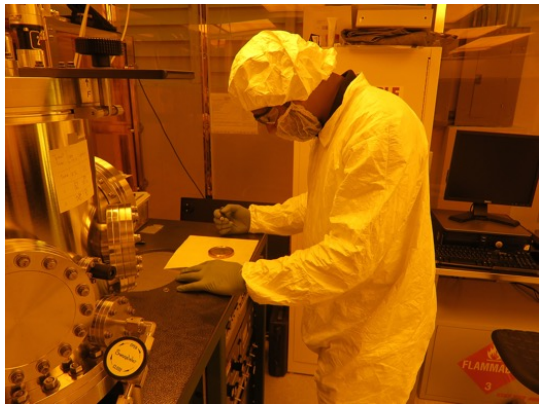
PhDs in Chemical Engineering

MS in Industrial, Civil, and Mechanical Engineering

And when the night is darker / Thou shalt shine brighter

The Center's productivity went through the roof in the reporting period after the storm, i.e., from April 2018 through March 2019.

Our Class 100 clean room was not operational for 5 months after the hurricane. During the reporting period, slowly through a technician and a grad student's relentless work, it became fully operational.



Reported product	Number
Book chapter	1
Journal or juried conference papers	24
New website	1
Other conference presentations	51
Patents	4
Master's theses	4
Doctoral dissertations	5
… And one educational video game!	

On April 13, 2019, the Center ran interactive demonstrations on nanotechnology at the Mayagüez Mall from 9am – 8pm. The *Nanito's video game* was a center piece of the activity.

Our *Nanomobile* visited Vieques assisting our Material Advantage student chapter's activity Ceramics in Engineering Showdown on April 26, 2019.

Acknowledgment

Hereby, Nanito would like to acknowledge our brave CREST community: grads and undergrads, professors, administrative personnel, teachers and our youngest warriors and their families.

crest UPRM II
crest2.uprm.edu

Dr. Andrea Johnson, NSF HSI program officer, meets our CREST students in November 2018 at the GRIC

NSF

Ecosystem to Expand Capabilities and Opportunities for STEM Scholars (EECOS)

Dr. Canny Bellido, Co-Pi Socioemotional Support

NSF EECOS STEM # 1833989

Stories of Despair

llegar a la casa, no podíamos salir del asombro. El río se había salido de su cauce e inundó nuestra casita convirtiéndola en una mole de fango. No había manera de entra pues aún tenía mucha agua. Poco a poco y pasando mucho trabajo logramos ir sacando un poco el fango. No había agua potable y se nos hacía difícil bregar. Estuvimos varios días trabajando hasta que al fin pudimos sacar parte del fango. Perdí TODO, enseres, ropa, muebles, ropa de cama, estufa, etc. Como pobre tenía mis cositas, lloré, lloré y lloré. Sin luz y sin agua no podíamos seguir bregando. Nos mantuvimos en casa de mis papás por 6 largos y angustiosos meses. Que difícil situación con una hija pequeña, no

Como todos sabemos, el semestre después de María fue uno muy irregular y fuerte para nosotros los estudiantes, pues el tiempo fue menor y teníamos mucho material que aprender. Encima de esto, tenía la responsabilidad de viajar constantemente a mi casa en Carolina, para ayudar a mi papá en las reparaciones, ya que carecíamos de fondos, y no teníamos presupuesto para estar pagar mano de obra, por ende, el trabajo lo hemos estado haciendo entre mi papá y yo. Actualmente, mi familia y yo seguimos inmersos todavía en el proceso de recuperación, ya que aún nos quedan áreas por reparar. Seguimos haciendo los recortes necesarios y solicitando las ayudas disponibles, para terminar las reparaciones necesarias y seguir adelante después de tal mientras tanto, con la ayuda de Dios la lucha sigue, y rendirnos no es una opción.

Al igual que muchos lo perdí todo, ropa, cama, fotografías de la infancia, etc. Todo sumergido bajo 3 pies de agua y babote. Mientras sacaba mis cosas para llevarlas a desperdicio, escuché la voz de mi familia en otro cuarto conversando y en momento entendí que nada había perdido. Siempre supe lo que significab

Llegue a P.R. sin nada de dinero debido a los gastos a los que tuve que incurrir. La situación económica y de vivienda infrahumana no había cambiado y ahora tenía que reanudar las clases, lo que implicaba que tenía que llegar al colegio sin contar con transportación, agua y luz. Como respuesta mi promedio se vio afectado ya que de 3.20 baje a 2.95, fracase en clases y perdí mi beca estudiantil por lo que tuve que solicitar una apelación que resulto afirmativa. Actualmente sigo enfrentando problemas económicos y de salud emocional. Cualquier ayuda es agradecida.

EECOS Project Objectives

Goal 1: To provide 26 academically talented, low-income, undergraduate UPRM STEM students that have been severely impacted by Hurricane María, **with the financial, academic, and socio-emotional support** they need to expand their personal and professional capabilities necessary to successfully enter the STEM workforce, and to complete their program within institutionally established time limits (retention and student success).

El colectivo, en una reunión reciente como parte de la agenda de trabajo del proyecto subvencionado por la NSF, que apoyará económicamente a 26 estudiantes subgraduados en disciplinas de ciencias e ingeniería. (Foto por Carlos Díaz)

Goal 2: To adapt and implement an ecosystem of proven financial, academic, and socio-emotional support strategies, **and to study the effect of that ecosystem on persistence and student success among academically talented, low income undergraduate UPRM STEM students.**

Goal 3: To contribute to the implementation and sustainability of effective evidence-based co-curricular activities for low-income academically talented undergraduate UPRM STEM students severely impacted by Hurricane María, who are pursuing undergraduate education with the intent **to pursue graduate education, and entry into the STEM workfor**ce.

Cuatro investigadoras del grupo a cargo de Ecosystem to Expand Capabilities and Opportunities for STEM Scholars, acompañadas por la rectora interina Wilma L. Santiago Gabriaini, al frente a la izquierda. En el mismo orden, las doctoras Mónica Alfaro, y atrás: Laura López, Bernadette M. Delgado y Carmen Ballido. (Foto por Carlos Díaz)

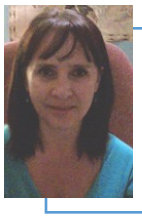
EECOS Intelectual Merit

- Although the principal proposed interventions, including academic mentoring and socio-emotional support with growth mindset modules are proven elsewhere, this is the first time they will be targeted at a population distressed by a disaster event.
- Produce a baseline characterization of the strength of each component within the ecosystem that will increase student retention and promote student success.
- These components may serve as useful tools for faster and more effective responses in crisis or other similar hardship situations in the future.

Broader Impact

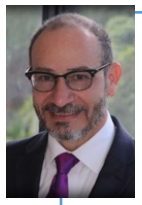
Materials used and lessons learned will be communicated to the broader university academic community nation-wide, in order to provide a framework for support of students after crisis events.

lemic Support - Mentors



PI - Dr. Mónica Alfaro
Biology, Industrial Microbiology
Mentees: 7

CoPI - Dr. Nayda Santiago
Computer, Mechanical & Electrical Engineering
Mentees: 7



Dr. Moises Orengo
Physics, Biotecnology, Math, Geology, PreMed, Nursing
Mentees: 8

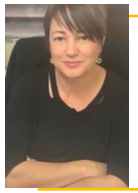
Dr. Lourdes Medina
Industrial, Mechanical & Civil Engineering
Mentees: 6

Dr. M. Laura Cuevas
Chemistry, Agronomy, Biotechnology, Chemical Engineering
Mentees: 8

Dr. Jose Fernando Vega
Electrical, Computer, Civil & Mechanical Engineering
Mentees: 6

Dr. Bernadette Delgado
Formative Evaluator

Socioemotional Support

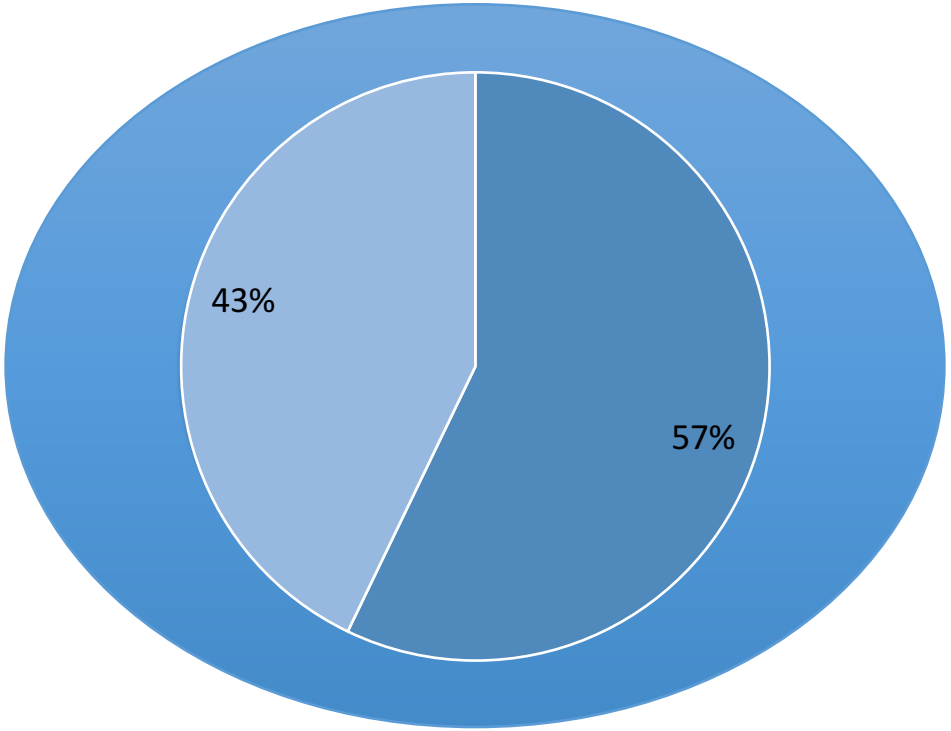


Co-PI Dr. Canny Bellido
Socioemotional Support

Financial Support

Co-PI Prof. Mercedes Ferrer
Financial Support

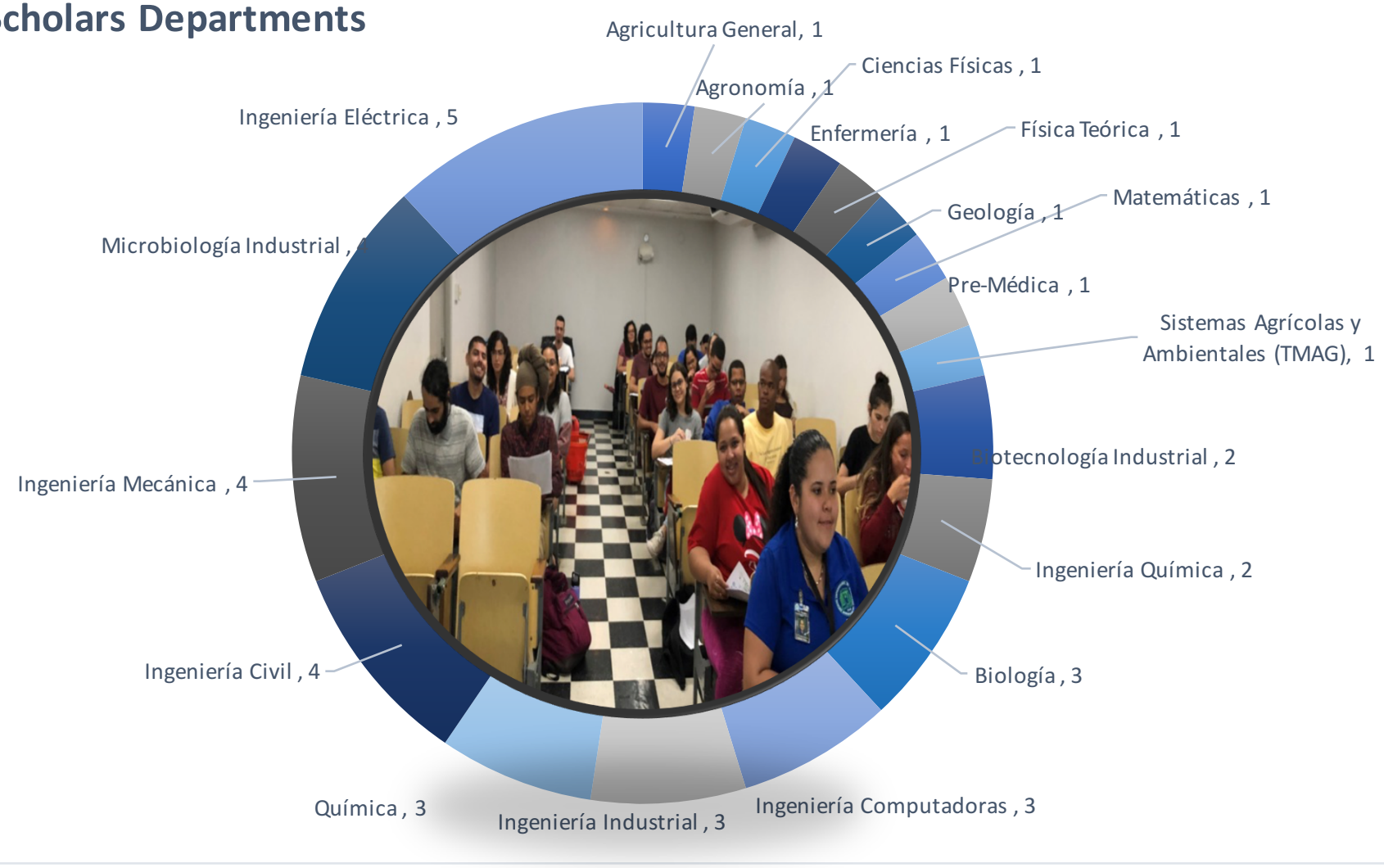
EECOS Scholars Demographics



Total:
42 - 1rst Sem 2018-19
40 - 2nd Sem

GPA Range: 2.28-3.92 Average GPA: 2.98 GPA Mode:2.95
From 30 Towns in PR

EECOS Scholars Departments



EECOS Financial Support 2018-2019

Semester 2018-19	Scholarships awarded	Financial support
1st semester	42	$105,000.00
2nd semester	40	$100,000.00

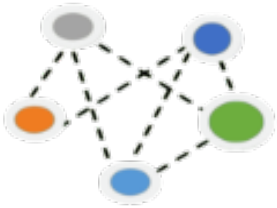
Total of $205,000 scholarships awarded

Academic Support Activities

15 Professional development activities invited to participate Spring semester 2018-19.

Collaborations with other projects – MARC, E- Ship Network, RUMboEx, Biology Department, ePearls, CAHSI

2 individual meetings of the Academic Mentor with each scholar per semester.

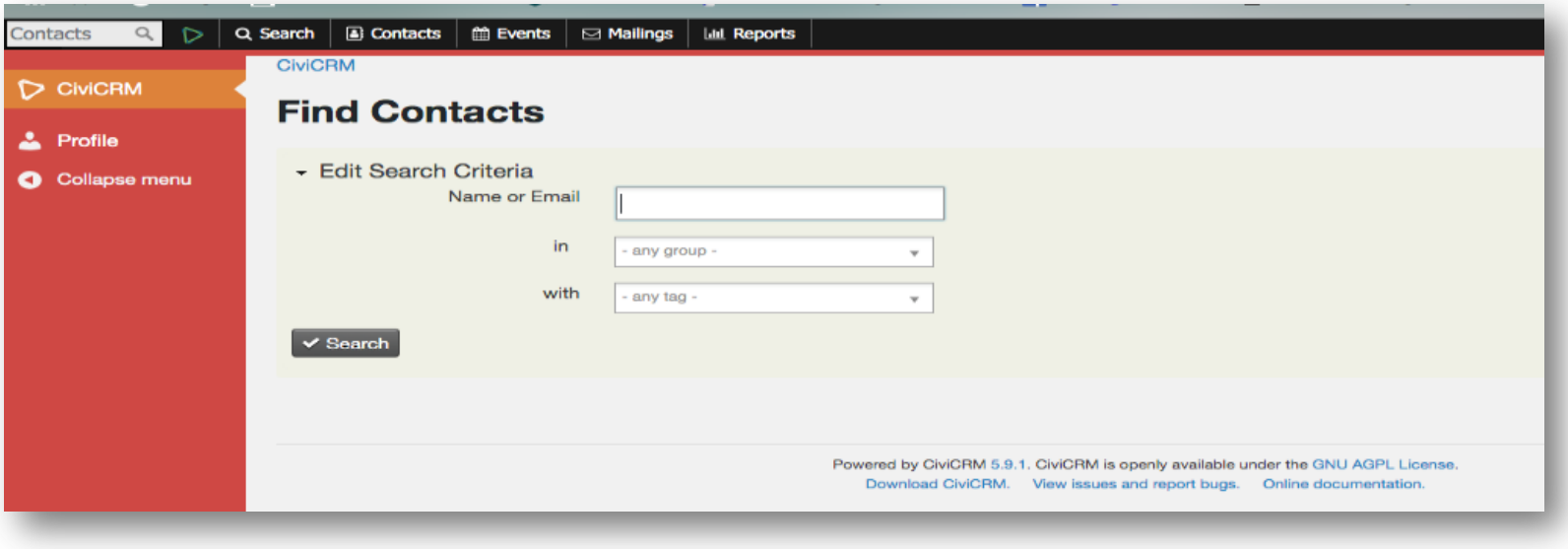


UPRM E-Ship NETWORK

Centro de Aprendizaje y Éxito RUMbo EX UPRM

Academic Support

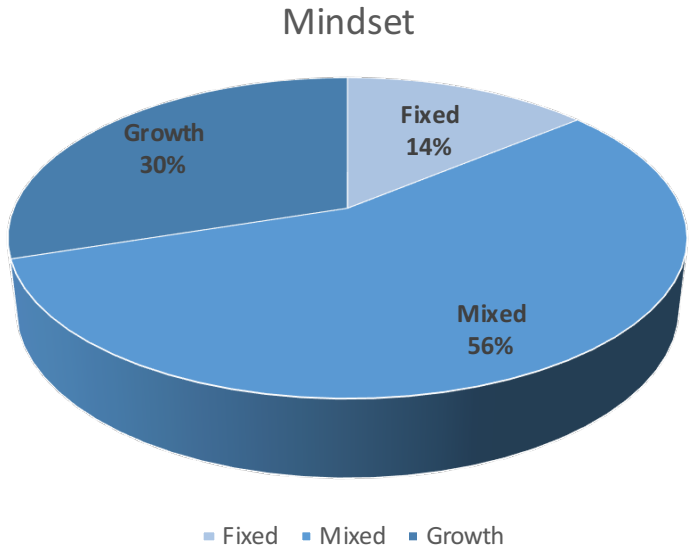
- CiviCRM Platform
  - Open source database to register all interactions of mentor and mentee.

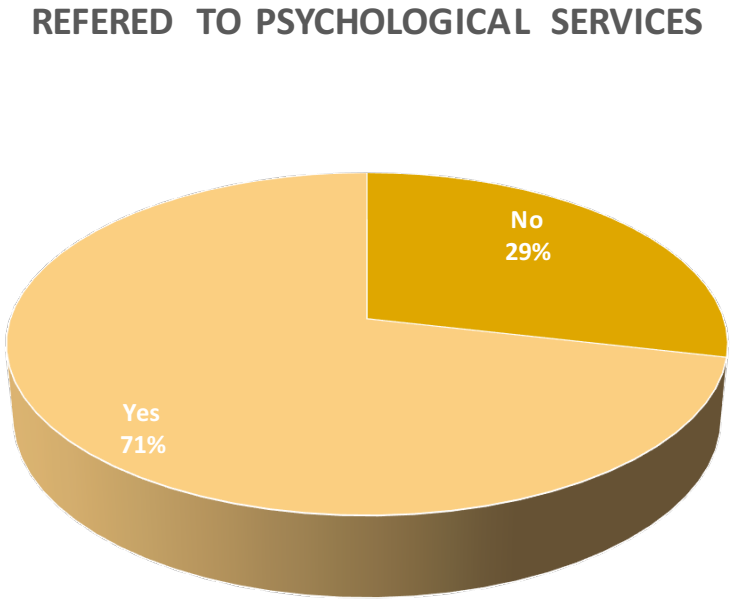


Socioemotional Support

Screening Tests (December 2018):

- Direct exposition to disaster
  - 100% high to severe.
- Beck Anxiety Inventory
  - 61% of scholars present high levels of anxiety





Socioemotional Online (Moodle) Support

Stories of Resilience

Hoy gracias a Dios, a mi familia, a la gente de mi departamento, compañeros de diferentes clases en ese entonces, pero en especial al Programa EECOS puedo decir que lo logré. Logré vencer todas esas adversidades que en algún momento me hicieron pensar quitarme, pero no aquí estoy, fuerte y decidida cumpliendo con mi rol de madre, esposa y estudiante.

Finalmente y para dar por terminado me encuentro a ley de días para desfilar en la Centésima Sexta Colación de Grados de la mejor Universidad de Puerto Rico, Recinto de Mayagüez, mejor conocida como el Antes, Ahora y Siempre…. COLEGIO!!!

Muchas Gracias…

20. Indicate knowledge, skills, and/or attitude change acquired a result of the mentoring relationship.

15 responses

Better understanding of my opportunities to my future goals, how important is the emotional area in my life, how can i organize for the lest of my academic years, how to open up more and develop myself better as a professional.
Think outside the box, be more empath & know that there's people with bigger problems than mine.
I now have a different approach when studying for my harder classes thanks to my mentor's advice.
I learned how to learn better and organize myself better.
Aprendi a organizar mi tiempo. Aunque sí me gustaría mejorarlo.
Estoy estudiando más efectivamente gracias a ella y he aprendido a dejar de trancarme por mis errores, aprender de ellos y mejorar académicamente.
She helped me to organize and prepare plans to have a better result when dividing time and evaluating more effective times or profit to study.
Better organization
My attitude is more optimistic now that I have mentoring
Estoy mas enfocado en seguir estudiando en estudios graduados.

Engineering PEARLS

Program for Engineering Access, Retention, and LIATS Success

Program Overview

Dr. Manuel Jimenez, PI

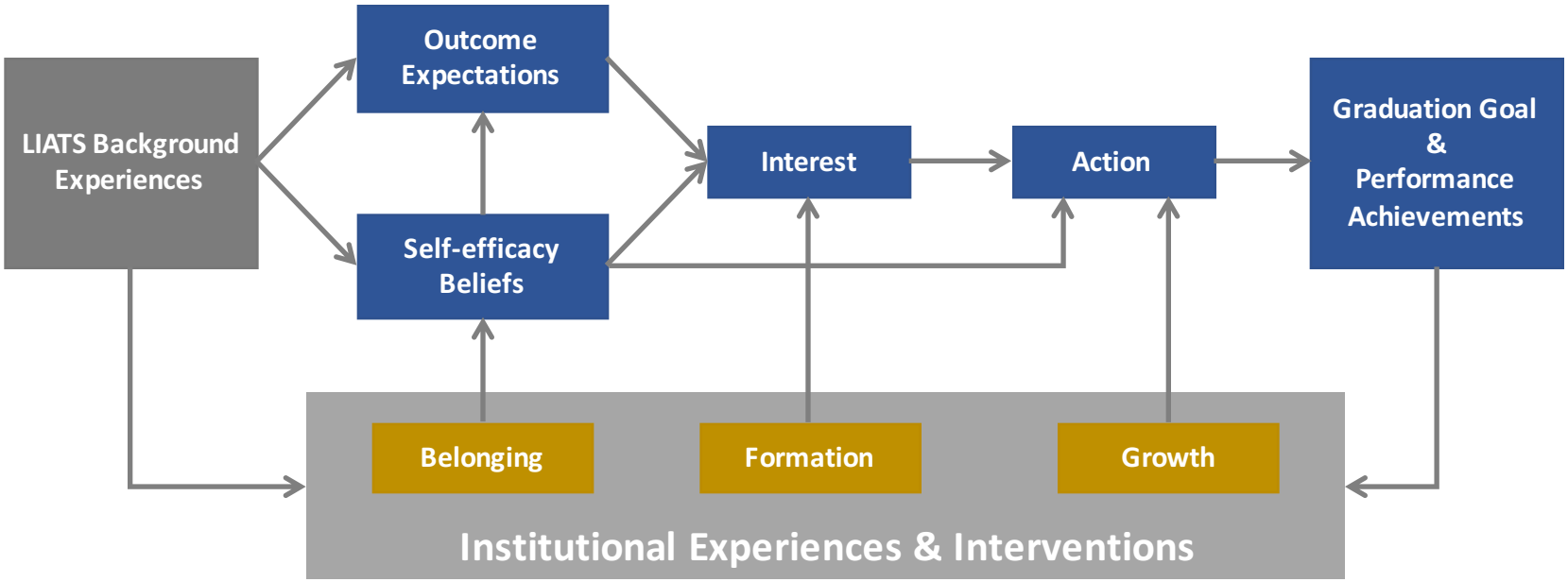
NSF S-STEM
DUE 1833869

Co-Pis: Dr. Sonia Bartolomei, Dr. Marcelo Suárez, Dr. Aidsa Santiago
Senior Personnel: Dr. Nayda Santiago, Dr. Pedro Quintero, Dr. Carla López del Puerto, Dr. Nelson Cardona, Dr. Anidza Valentin
Evaluators: Dr. Luisa Guillemard, Dr. Janet Bonilla

Objectives and Vision

- **Project Objectives**
  - Increasing the retention and success of low-income, academically talented students (LIATS) in engineering
  - Researching an intervention model based on social cognitive career theory and attrition mitigation, in a framework provided by a structured scholarship program
- **Mission**
  - Recruiting, Retaining, and Engaging Academically Talented Students from Economically Disadvantaged Groups into a Pathway to Successful Engineering Careers
- **Vision**
  - Providing guidelines to establish institutional policies and practices for improving LIATS success

College Access & Success Model



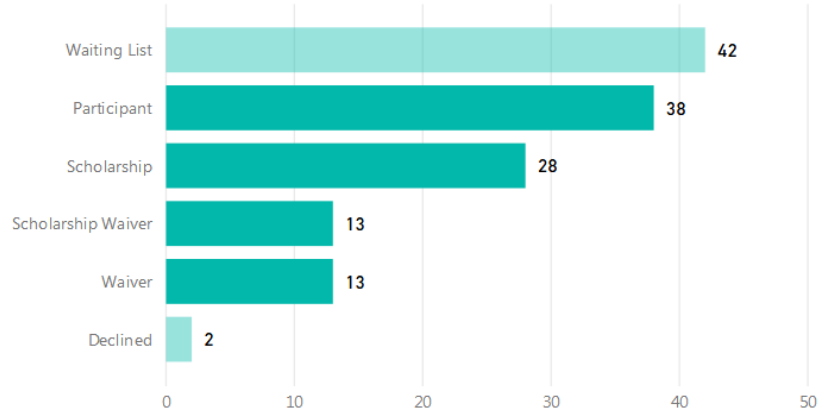
Engineering PEARLS
Program for Engineering Access, Retention, and LIATS Success

LIAT College Access & Success Model

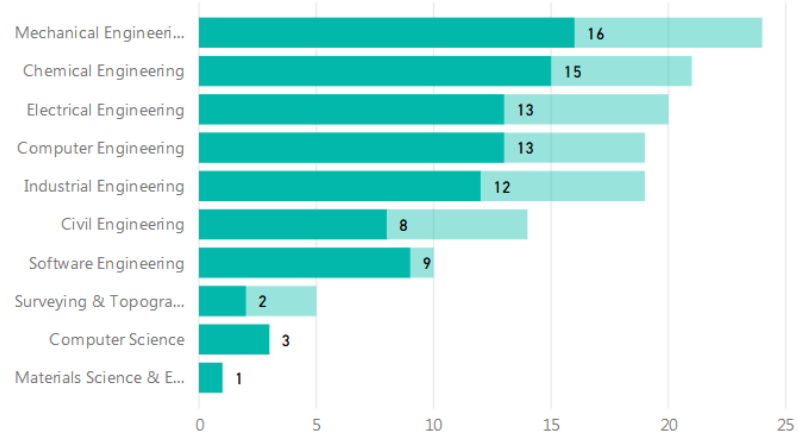
ENGINEERING PEARLS
Program for Engineering Access, Retention and LSATS Success
NSF-SSTEM DUE 1833869

92
Students

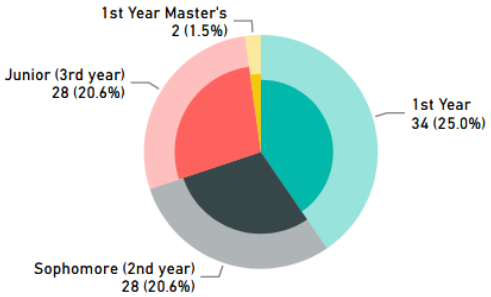
Participation Level



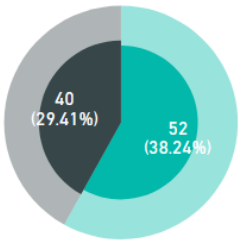
Study Program



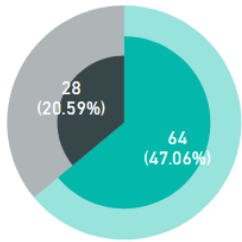
Academic Level



Gender: Male Female



School Type: Public Private



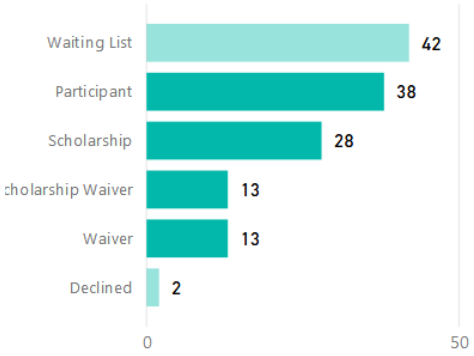
Reset Filters

ENGINEERING PEARLS
Program for Engineering Access, Retention and LSATS Success
NSF-SSTEM DUE 1833869

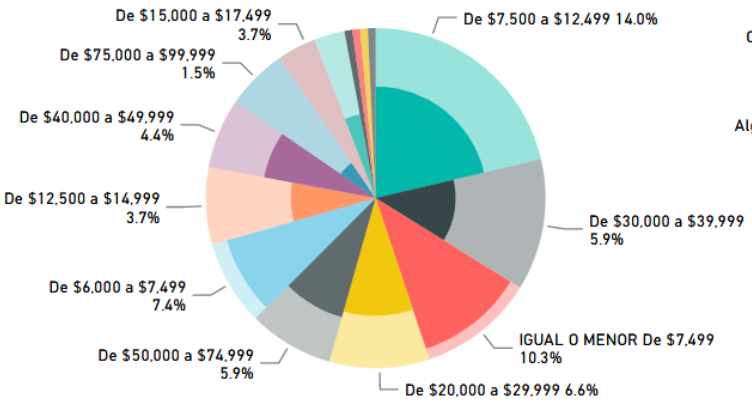
Study Program

Study Program	Students
Mechanical Engineering	16
Chemical Engineering	15
Computer Engineering	13
Electrical Engineering	13
Industrial Engineering	12
Software Engineering	9
Civil Engineering	8
Computer Science	3
Surveying & Topography	2
Materials Science & Engineering	1
Total	**92**

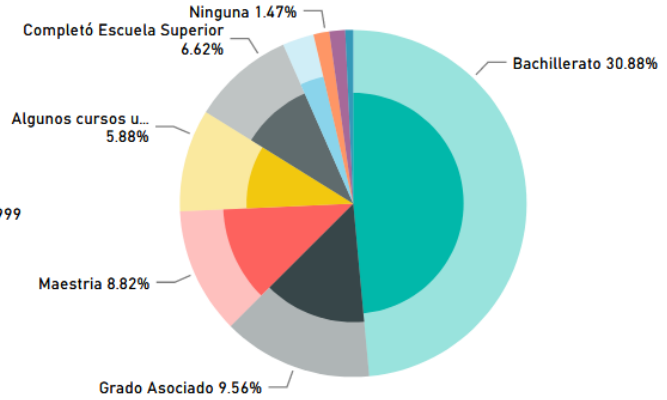
Participation Level



Household Income

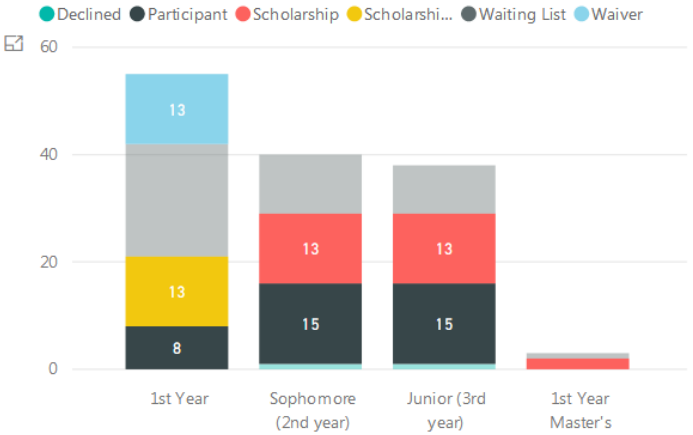


Mother Education

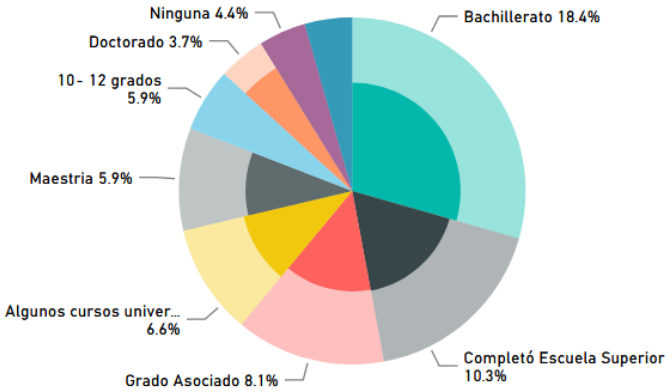


92
Students

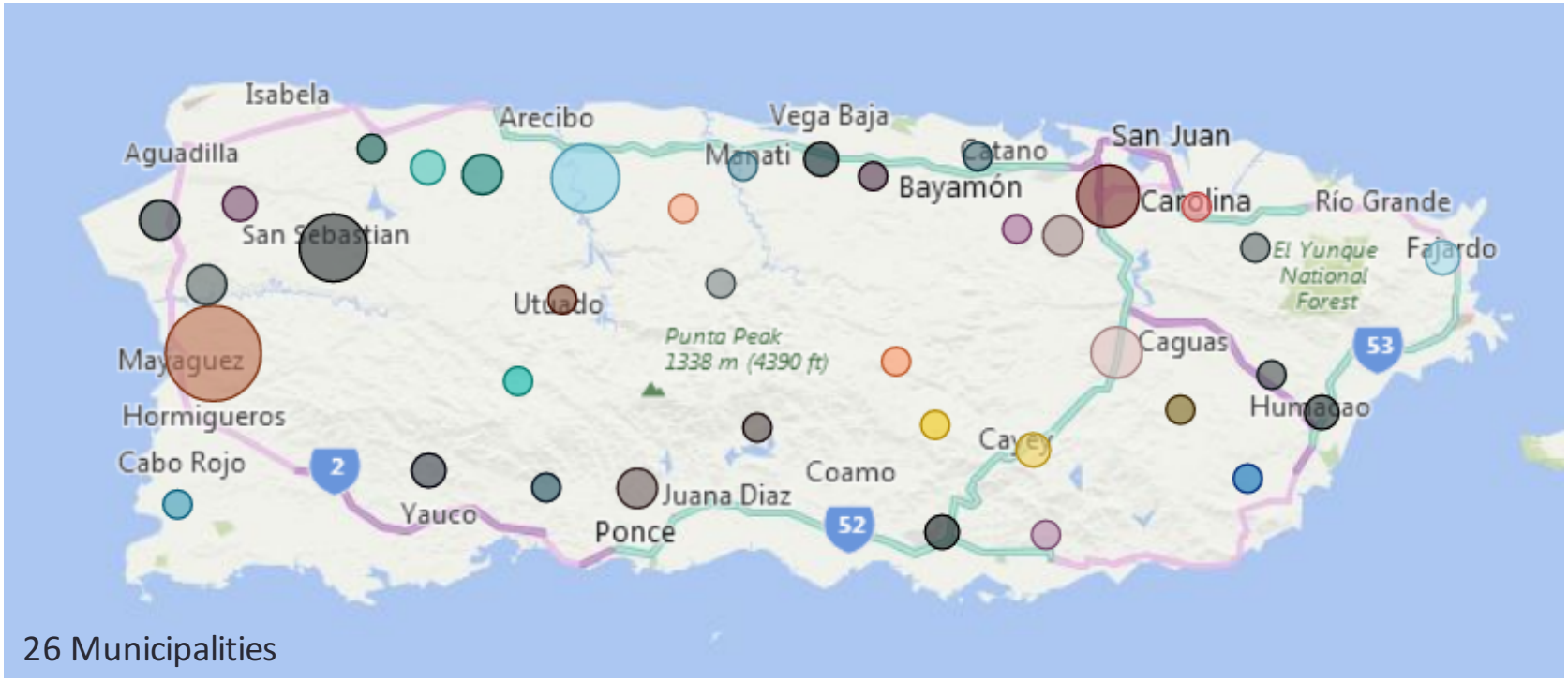
Students by Year



Father Education



Student Distribution by Municipality



26 Municipalities

City	Students
San Sebastián	6
Ponce	5
Aguada	4
Utuado	4
Bayamón	3
Caguas	3
Camuy	3
Añasco	2
Carolina	2
Cayey	2
Cidra	2
Hatillo	2
Humacao	2
Moca	2
Quebradillas	2
Salinas	2
San Juan	2
Vega Baja	2
Yauco	2
Adjuntas	1
Aguas Buenas	1
Aibonito	1
Barranquitas	1
Cabo Rojo	1
Canóvanas	1
Ciales	1
Total	**92**

First-year students

Second-year students

Third-year students

Contact US

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Engineering PEARLS
Program for Engineering Access, Retention, and LIATS Success

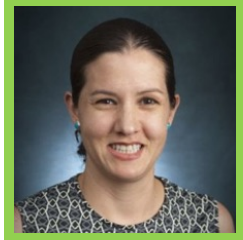
RISE UP

Collaborative Research on **R**esilient **I**nfrastructure and **S**ustainability **E**ducation - **U**ndergraduate **P**rogram

HSI# 1832468; 1832427

RISE up

HSI# 1832468; 1832427



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External Evaluator - Walter Díaz

RISE up

Our purpose is to **educate** future environmental designers and engineering to **plan and build a more resilient and sustainable infrastructure for Puerto R**ico, through

- Interdisciplinary program in resilient infrastructure and sustainability
- Rapid response and resilience to counter natural disasters
- Novel curricular sequence
- Undergraduate research and internships opportunities

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RISE up

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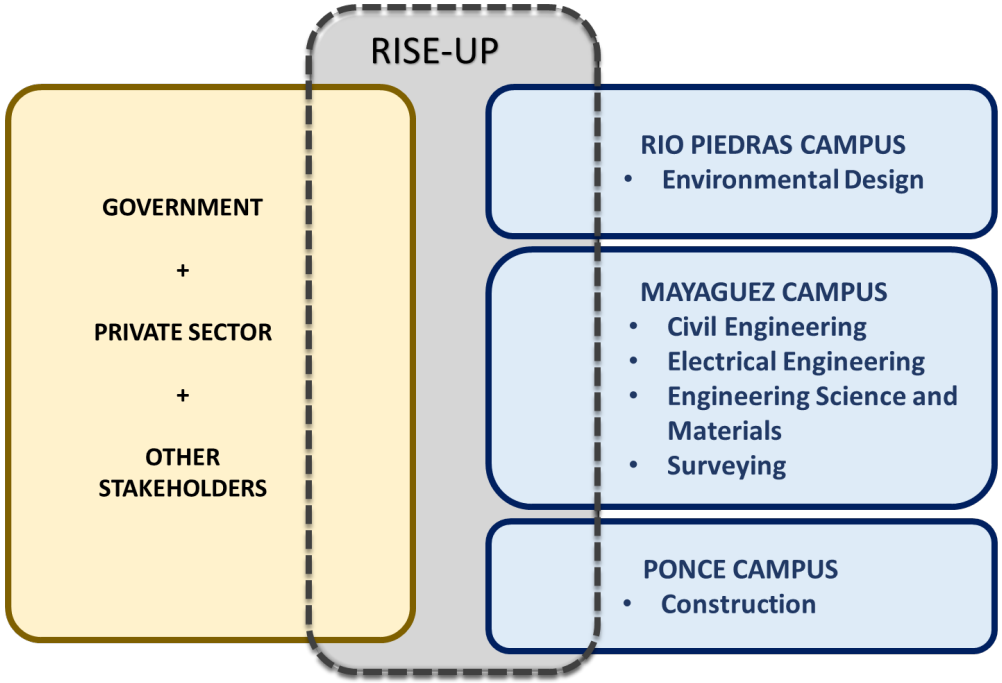
BROADER IMPACT

- To benefit society by increasing capacity of engineers, surveyors and environmental designers
- To work on issues related to resiliency and sustainability
- Development of a database of case studies available for research and modeling.

RISE UP



High Impact Collaborative Structure

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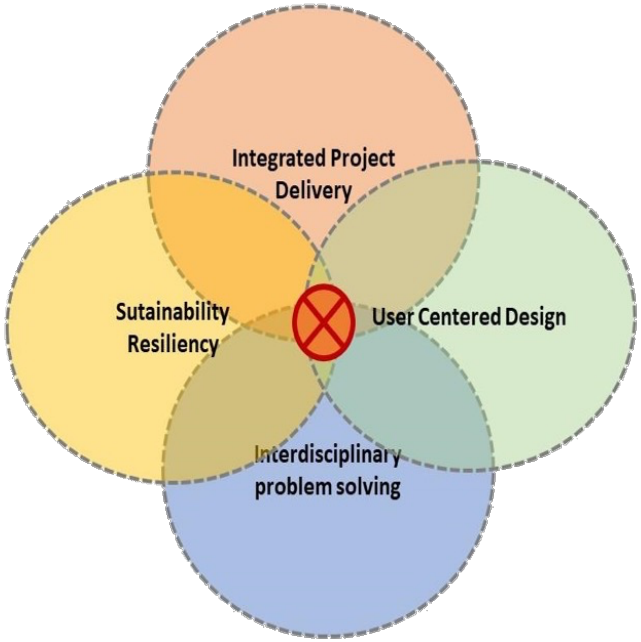
RISE up

INTERDISCIPLINARY CURRICULUM DEVELOPMENT



All courses share a common goal of creating synergetic interactions among these four domains:

- Integrated Project Delivery
- User-centered design
- Problem-solving
- Sustainability and resiliency

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RISE UP

Courses

Level	RISE-UP Courses	Credits
1	Fundamentals of Integrated Practice for Resilient and Sustainable Infrastructure*	3
2	RISE-UP Seminar Series	3
3	Experiential Learning (Internship/ Undergraduate Research)	3
4	Resilient and Sustainable Design and Construction *	3
5	Design- Build Project Delivery *	3

* Proposed courses subject to change, approval pending.

Total Credits 15

- Courses may be counted as free electives
- Levels 4 and 5 are advanced undergraduate (5000 level) courses which may be used as part of a graduate program at UPR.

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RISE UP

Experiential Learning

- Targeted undergraduate research and internship opportunities
- Integration with the curricular development
- Enhanced retention and success among undergraduates
- Experiential learning to assess and ameliorate the vulnerability of the infrastructure
- Resiliency in logistics associated with infrastructure (from construction to reliable power and communications)
- The experiential learning component as an integral part of the environmental design, civil, electrical and materials engineering, construction, and complementary areas
- Training as a critical component of RISE-UP strategy

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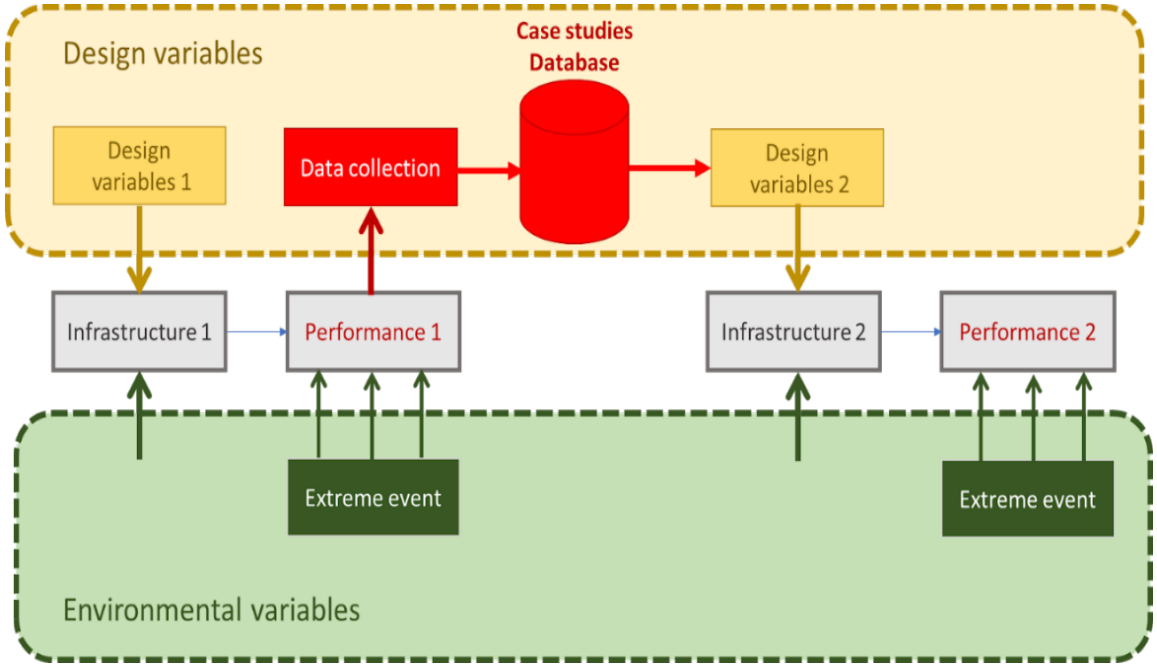
RISE up

Database



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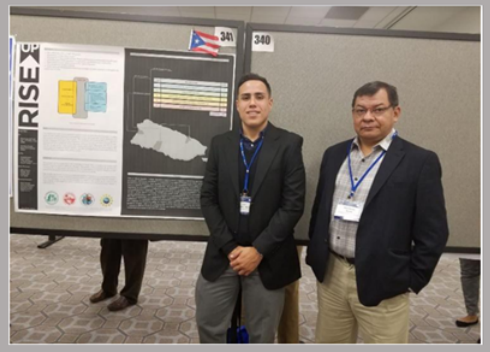
RISE UP

Activities

UPR Ponce students visiting the materials lab at the Civil Engineering building, UPR Mayagüez

Understanding Earthquake Effects on Structures with Experimental Learning Utilizing a Shaking Table



RISE-UP Program Poster Presented at the 2019 Emerging Researchers National (ERN) in STEM Conference

HSI Conference, Mayagüez, PR

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RISE

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Disclaimer

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HSI# 1832468; 1832427
1345156; 1833869; 1833989